A Discussion of the Integrated Students' System Based on MAS

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Abstract-**The integrated students' system based on Multi-Agent System (MAS) is a typical case of open complex intelligent systems. Users' demands and modelling methods of the integrated students' system based on MAS are proposed in this paper, by using the theory of open complex intelligent systems. Moreover, the architecture for the integrated students' system is discussed. All these discussions are proposed as the analysis of a system. And we will do some simulation to test the system in the next research.**

Keywords-Agent; Multi-Agent System (MAS); the integrated students' system; Complex Adaptive System (CAS) theory; strategy of MAS development

I. INTRODUCTION

With the development of information technology and Internet, digital campus entered each university. In the development of digital campus, University Resource Planning (URP) was propounded by some scholars. The planning is similar to the Enterprise Resource Planning (ERP). It is a solution for digital campus and an integrated system for university's information systems [1]. Tsinghua University presented a concrete proposal as a platform + N application systems + a portal. At the same time, the integrated students' system emerged as the times require. It is a whole of student-oriented management and service systems, integrated by overall student-related systems in digital campus [2].

A new design of the integrated students' system based on MAS is proposed in this paper. We view each system in the integrated system as a sub-system and use operational agents and managed agents to collaborate. The autonomy and cooperation of each agent help to implement the interaction between system and users, in order to prove the strong adaptability and intelligence.

II. THE OVERVIEW OF MAS

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A. Agent

Nowadays, there is not a specific definition about 'Agent'. Scholars like Wooldrige and Shoham gave the weak definition and strong definition for it. From Wikipedia, Agent may refer to one who acts for, or in the place of, another, by authority from him; one entrusted with the business of another. In computer science and artificial intelligence, Software agent is a piece of software that acts for a user or other program in a relationship of agency [3]. Besides, agent may have some concepts like belief, desire, intention, and goal. And more and more exports share this view that agent has four basic features: autonomy, pro-activity, reactivity and social ability.

B. Multi-Agent System

A multi-agent system (MAS) is a system composed of multiple interacting intelligent agents. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve [4].

Reference [5] makes a further explanation of it. Each functional module in MAS is composed of an agent coordinator and many sub-agents. Each sub-agent is assigned certain duties, and every agent coordinator has the responsibility to coordinate each sub-agent in order to obtain the module's integrated function. A MAS has the ability of coordination and cooperation to interact with its located environment, other agents and humans. Moreover, the goal and the behaviour of each agent are relatively free and independent.

C. The strategy of MAS Development in Open Complex Intelligent Systems

According to the Complex Adaptive System (CAS) theory, combined with the strategy of information system development and the framework for MAS Development, we propose a new strategy of MAS development for open complex intelligent systems. It can be illustrated in Figure 1 as follows:

1) Free-flowing information flow. CAS theory proposed the concept of flow and took each kind of flow's analysis as the most important issue in the development of complex system. What's more, it takes the exchange and processing of information as the vital attribute which affect the system's evolvement into consideration. In software engineering, data description is also the first stage in lifecycle of software.

The thought of flow services the whole development. Between the communication of agents and interaction of agents and environment, the free-flowing information flow becomes the major guideline. The information flow is an important evaluation of MAS in the stage of analysis and design. If it cannot flow freely though the system, something wrong will be happened and have bad influence in the stage of development and maintenance. To solve this problem, we must follow the direction of information flow and transmission of messages.

2) Non-linear thought. It is also an important characteristic in CAS theory. The CAS theory attributes it to the initiative and adaptability of adaptive agent, and considers it as the origin of complexity [6]. In the development of MAS, especially the prototype methods, developers may modify the system requirement circularly according to users' demands.

Thus, using non -linear thought is the best policy to return to the previous stages and revise the system.

3) Agents' diversity. Each Agent in MAS has its own goal, belief, desire and intention. Realizing the situation of environment through the modules of belief and intention, combining with its goal and desire, an agent can select and complete its duties automatically. Therefore, in the stage of analysis and design, we should pay more attention to agents' diversity. Furthermore, in the process of agents' adaptation to environments, differences among agents will be expanded and cause the differentiation finally. This is another outstanding feature of CAS theory. In a word, we must regard the structure emergence of MAS in a macroscopic perspective.

4) Internal models and building blocks. They are the two important mechanisms of CAS theory, reflecting the concept of hierarchy. When spanning levels, there will be new laws and characteristics appeared. At this time, we can package content and laws of low level into a whole. When interacting with high level, we can abandon its internal details for the time being and pay attention to the interaction and influence between this building block and others. The interaction and influence take crucial effect because they are the key factors in the low level.

5) Aggregation. It refers to the development of adaptive agent in a new and more feasible environment rather than disappearance. After aggregation of agents in different levels, agents of the higher level will come into being. In the evolutionary process of complex system, agents of low levels form congeries of high levels in a certain way after aggregation, in order to complete the specific function. In the agents' integration process of MAS, many agents construct the relational agent groups through aggregation. Besides, each agent in the groups joins up to accomplish a more complex task.

In the stage of analysis and design, we should pay more attention to agent's data and operation when approaching its goal and agent's integration when completing the complex task. At the same time, note the study and memory ability of agent in the information flow.

In conclusion, an agent can interacts with environment and other agents and accumulates experience during this process, in order to change its own structure and behaviour And MAS is a complex system that needs to be analysed and designed by using CAS theory.

III. ANALYSIS OF THE INTEGRATED STUDENTS' SYSTEM

In the period from entrance to graduation, the integrated students' system services all the students, teachers, leaders and alumni with all kinds of management, providing an integrated information platform to communicate [2].

A. Organization-oriented System Analysis

Early requirement analysis and late requirement analysis are included in this system analyses. Concretely speaking, the basic tasks of system analysis for open complex intelligent systems consist of collecting information, defining requirement, filtering requirement, developing the prototype, optimizing option, requirement modelling, evaluating & recommending, and mechanism changing[9]. Therefore, system analysis of the integrated students' system has the following phases to abide by.

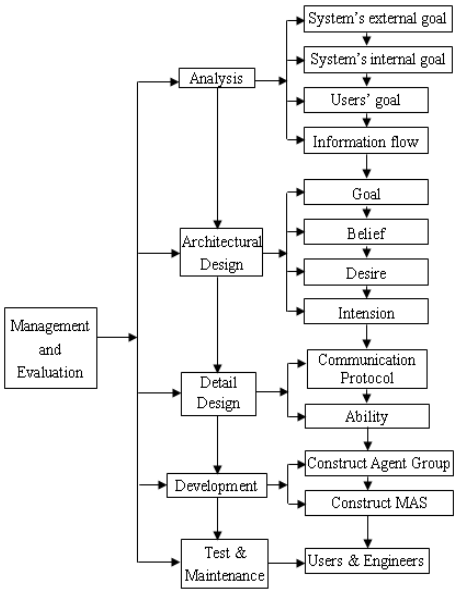

Fig. 1 The Strategy of MAS Development for open complex intelligent systems

1) Collecting information. Students are the subject of the integrated students' system. The system acquires the evaluation of teachers, students and courses when it is servicing. And then it offers the data as the principle of decision-making. Moreover, the integrated students' system tries its best to let users enjoy personalized service through agent technology.

2) Defining requirement. As we all known that instruction is the main task of schools and students are the primary products of university. It gives birth to a great number of stakeholders (such as parents, teachers, employer and alumni) and a series of operational requirements (such as safety, reliability, adaptability, compatible interface).

3) Filtering requirement. After acquiring requirement information, we have to sort out and refine them so as to create high level requirement documents.

4) Developing the prototype. Construct a prototype quickly and then check its sufficiency and necessity by confirming the requirement with users. After that, set the secondary requirements as options.

5) Optimizing option. Comparing with historical data we can have a further analysis, so as to ascertain the final requirements.

6) Requirement modelling. We use modular way in development, combined with UML and java language.

7) Evaluating & recommending. Users and system analyst evaluate the final requirements together, deciding whether it can step into the next stage or not.

8) Mechanism changing. If yes, we have to change and match the modules from analysis phase to design phase.

Finally, we can acquire a set of organization-oriented analysis as the output of this phase.

B. Theories of Integrated Modelling

It is better to model the open complex intelligent systems with integrated modelling method. For one thing, it can reflect information requirement more comprehensive and systemic. For another, it may arrange the list of all members relative to the system. Describing the members and their relationships, we can derive the model of analysis [9]. Accordingly, we adopt integrated modelling method to analyse the integrated students' system.

1) Functional Demand

The integrated students' system includes 5 modules: Business Management, Online Service, Educational Administration, Student Management and Instruction Platform. It uses B/S structure (Browser/Serve) and MVC developing method (Model, View, Controller) to achieve the functions of systems (Fig.2 & Table.2).In each sub-system, it utilizes its own application server and database server to implement uniform identity authentication.

2) Visual Modelling

To achieve Single Sign-on (SSO), we can use Unified Modelling Language (UML) for visual modelling.

3) Non-functional Demand

While inquiring data, its response time should be less than 10 seconds. The response time of other interaction should be controlled no more than 5 seconds.

In order to achieve system's reliability and availability, its fault should be less than twice in a month by setting checkpoint and restarting. We may insure its security by using technology of entity safety, access authorization and network firewall. Because of the object-oriented programming and hierarchical designing method, its logical structure is clear enough to make the maintenance and upgrading more convenient. On the other hand, software document and its management are also the important part in the life cycle of software. Authority documents can bring enormous efficiency and effectiveness to it. The integrated system can be transplanted to other kinds of operating systems by using java language and oracle database.

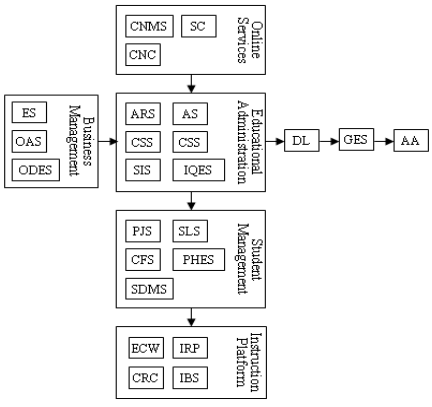

Fig. 2 Components of the Integrated Students' System

TABLE I
ABBREVIATIONS IN FIG. 2

Names of Sub-Systems (For Short)
Enrolment System(ES)
Office Automation System(OAS)
Official Documents Exchange System(ODES)
Campus Network Management System(CNMS)
Software Centre(SC)
Computer & Network Centre(CNC)
Activities Registration System(ARS)
Attendance System(AS)
Course Scheduling System(CSS)
Course Selection System(CSS)
Score Inquiry System(SIS)
Instruction Quality Evaluation System(IQES)
Part-time Jobs System(PJS)
Scholarship & Load System(SLS)
Credit File System(CFS)
Psychological Health Evaluation System(PHES)
Student Dormitory Management System(SDMS)
Excellent Curriculum Website(ECW)
Instruction Resources Platform(IRP)
Curriculum Resources Centre(CRC)
Item Bank System(IBS)
Digital Library(DL)
Graduation & Employment System(GES)
Alumni Association(AA)

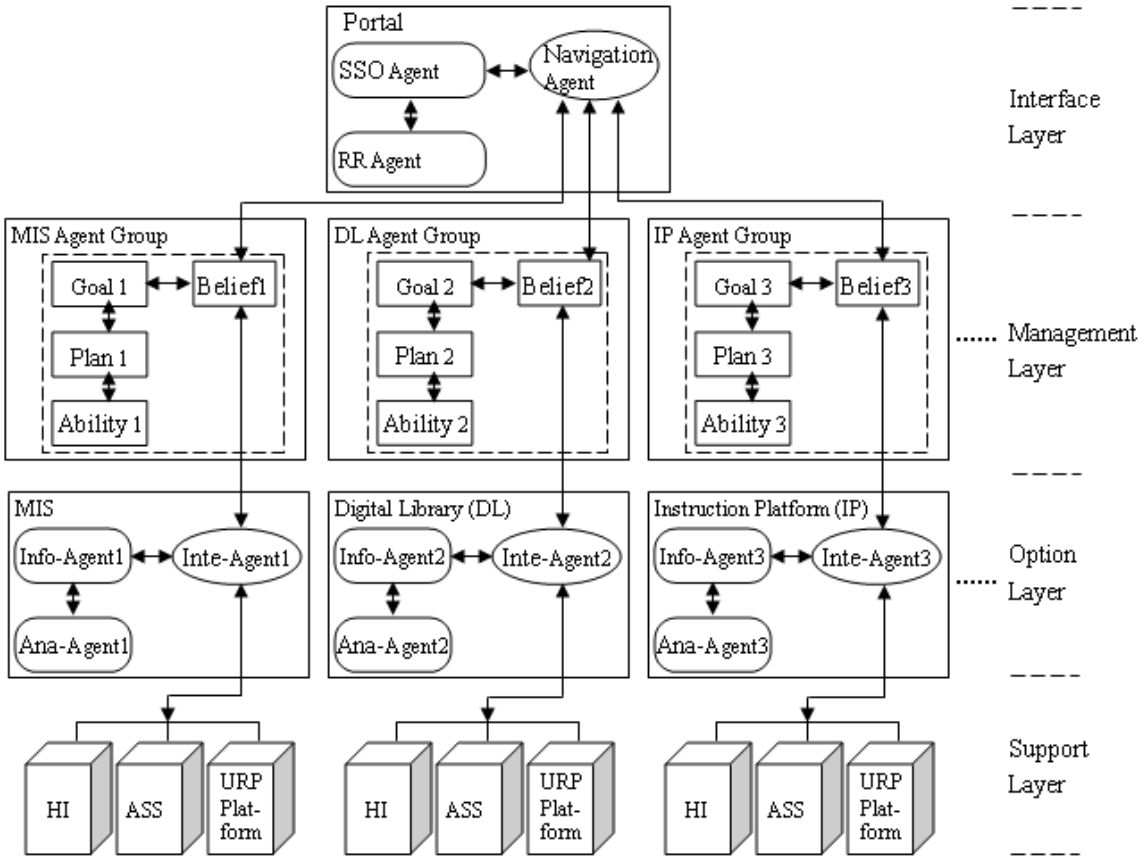

Fig. 3 the Integrated System's Architecture

TABLE Ⅱ
ABBREVIATIONS IN FIG.3

Abbreviations	Abbreviations
Single Sign-on (SSO)	Analysis Agent(Ana- Agent)
Resource Retrieval(RR)	Hardware Infrastructure(HI)
Information Agent(Info-Agent)	Application Support System(ASS)
Integration Agent(Inte-Agent)	

C. Members' Modelling

In the open complex intelligent systems, each member relates to some attribute and plays some roles. It may have some intelligence such as belief, expectation and intention. And then each role implements the action of some members, reflecting in the attribute. In order to show these relations, we have to establish members' modelling [9].

Take digital library of the integrated system as an example, it includes Circulation Management, Books Management, Readers Management, Managers Management, Query Management, Statistics Management and Analyses Management. Here, we can have readers' data (such as their reading hobby and knowledge structure) by using an agent to analyze their borrowing history.

IV. DESIGN OF THE INTEGRATED STUDENTS' SYSTEM

The integrated students' system based on MAS divides the whole system into multiple agents. In order to achieve the system's goal, we pay attention to the communication and collaboration of agents. It is easier to manage and implement each agent than the whole integrated system [10].

The characteristics of the integrated students' system based on MAS can be summarized as follows. To begin with, the system cuts the business of the complex system into many sub-

systems and assigns its tasks to corresponding agents. What's more, agents can be run in a parallel way to raise its efficiency. In addition, using modular design may add new agents easily to adapt the new demand, and improve the system's scalability and maintainability.

A. Design of the System's Architecture

According to the system's analyses, we establish its architecture as figure 3 and table 3. It contains 4 layers: support, option, management and interface [7, 10-11]. Support layer is the foundation of the integrated system while option and management layers are the core. And interface layer bridges the interaction between human and computer.

B. Design and Function Descriptions of Agent

1) Agents of option layer. There are all kinds of sub-system in this layer and each of them consists of information agent, analysis agent and integration agent. After analysis agent processing the data came from information agent, the integration agent returns it back to the upper layer (management layer). For example, information agent stores data of books and borrowing record. And then these data will be set to the analysis agent for further analyzing. These result data may support the decision making system by integration agent.

2) Agents of management layer. In this layer, there is an agent group relates to each sub-system. In each agent, it has its own goal, belief, plan and ability. When coming across a task, it can notice the environment and acquire data by its belief. Combined with its goal, it may plan and select the task which is suit for its ability to complete. Here, the belief of agent plays a role as a transmission among layers.

3) Agents of interface layer. They may receive the request from portal and sent it to agent groups. Then the agent groups call their corresponding sub-system into action.

Single Sign-on agent is the interface of users and system, providing logon, identification and permission checking service. Register only once, users can visit all sub-systems by navigation agent.

V. CONCLUSIONS

The integrated students' system based on MAS uses agents' intelligence, coordination and autonomy to accomplish its instruction and students' cultivation, and then achieve integrated management, information sharing, intelligent service and decision making.

The combination with the integrated students' system and cloud computing may become the next research direction. It will produce an effect for the analysis, design and implementation of Open Complex Intelligent Systems.

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